A Consistent Aquatic Monitoring Program; Are We Ready Yet?

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Keys Questions

- Is there a need for a consistent aquatic monitoring program within the Forest Service?

- What can be gained by integrating Forest Service Monitoring Efforts with other Federal, State, and private efforts?

- What Aspects of Monitoring Programs are Important for Consistency and Integration.

Have Aquatic Conditions Changed over the Last Decade?

To Have a Consistent or Integrated Program it Helps to Have Common Goals?

- Determine Whether the Aquatic Resources are Improving, Declining, or Remaining the Same at The Small To Large Scale.
    - Are These Changes Due to Changes in Management?
    - Are These Changes Due to Changes in Regulatory Policies?
- Site Specific Projects will Need Site Specific Aquatic Monitoring Programs.

Common Objective Not Enough: Also Need A Common Reason?

Consistent Forest Service Efforts.

- Permits Simple Combining of Data From Different Districts/Forest/Regions.
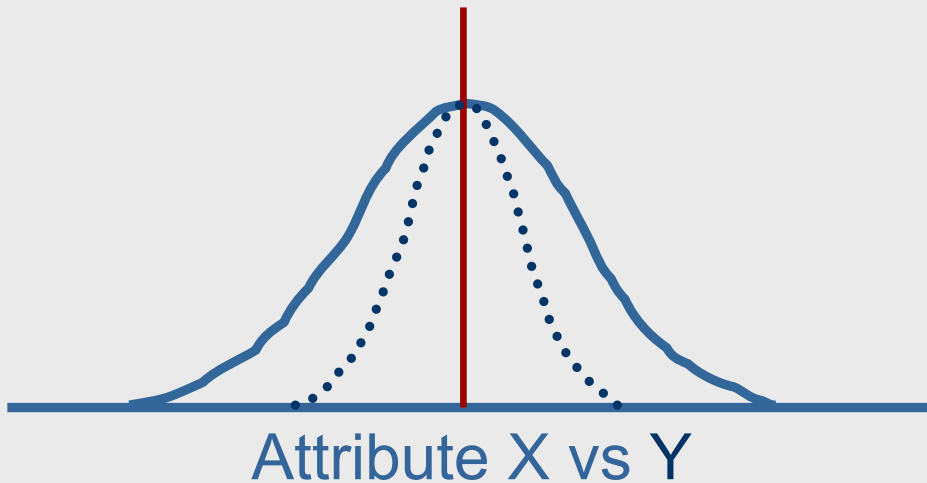- Higher Total Sample Size.
- Defensibility of Data Increases.

Integrated Federal, State, Tribal, and Private Efforts.

- Economies of Scale.
- Use of Data Not Paid For.
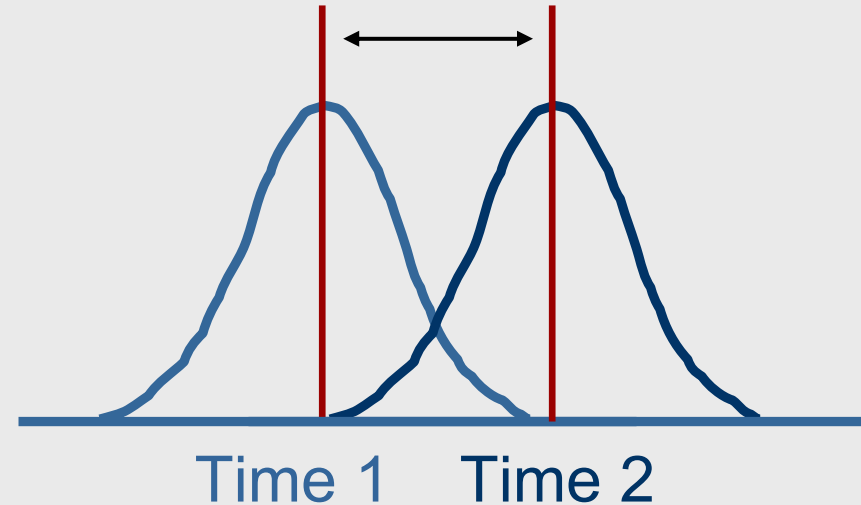
So What Are the Primary Concerns When Implementing any Aquatic Monitoring Program?

The Holy Trinity (or Mantra) For Assessing Aquatic Condition.

How Variable

Attribute X vs Y

How Different

Time 1   Time 2
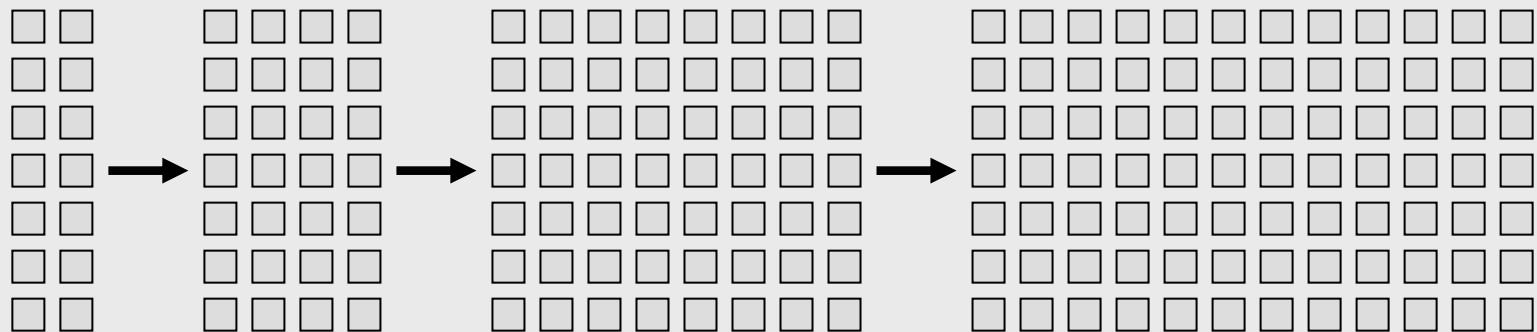
How Many Samples

So How do Monitoring Programs Influence Variability, Differences, and Sample Size?

- ■ Sample Design.
  - ■ How, When, and Where We Measure.
- ■ Response Design.
  - ■ What Attributes We Evaluate and How We Evaluate Them.
- ■ Procedural Design.
  - ■ How We Insure What We Planned to Do Gets Done The Way It Was Planned.

Sample Design

What Aspects of Sample Designs Permits Aquatic Monitoring Programs to be Integrated?

1. A Probabilistic Sampling Approach.

2. A Design that can Evaluate Aquatic Conditions at a Variety of Scales.

3. A Design that Provides Information on both Status and Trend.

4. One that Recognizes and Identifies the Population of Interest.

Why A Probabilistic Sampling Strategy?

"Regional trends often are inferred from accumulation of site-specific trends. Local decisions often dictate the selection of sites, without due regard to a regional sampling design. As a consequence, regional inferences are subject to questions about bias in the selection of sites on which the regional trend inferences are made."

Urquhart et al. 1998

How do we Insure Aquatic Condition can be evaluated at a Variety of Scales?

The Answer for this Question Has Been Provided By the EPA Western Ecology Division – Spatially Restricted (Balanced) Design.

- Distributes Sample over Area of Interest.
- Variable Spatial Density.
- Nested Sub sampling
- Can Incorporate a Variety of Sampling Strategies.

So What is A Spatially Restricted (Balanced) Sample Design Really?
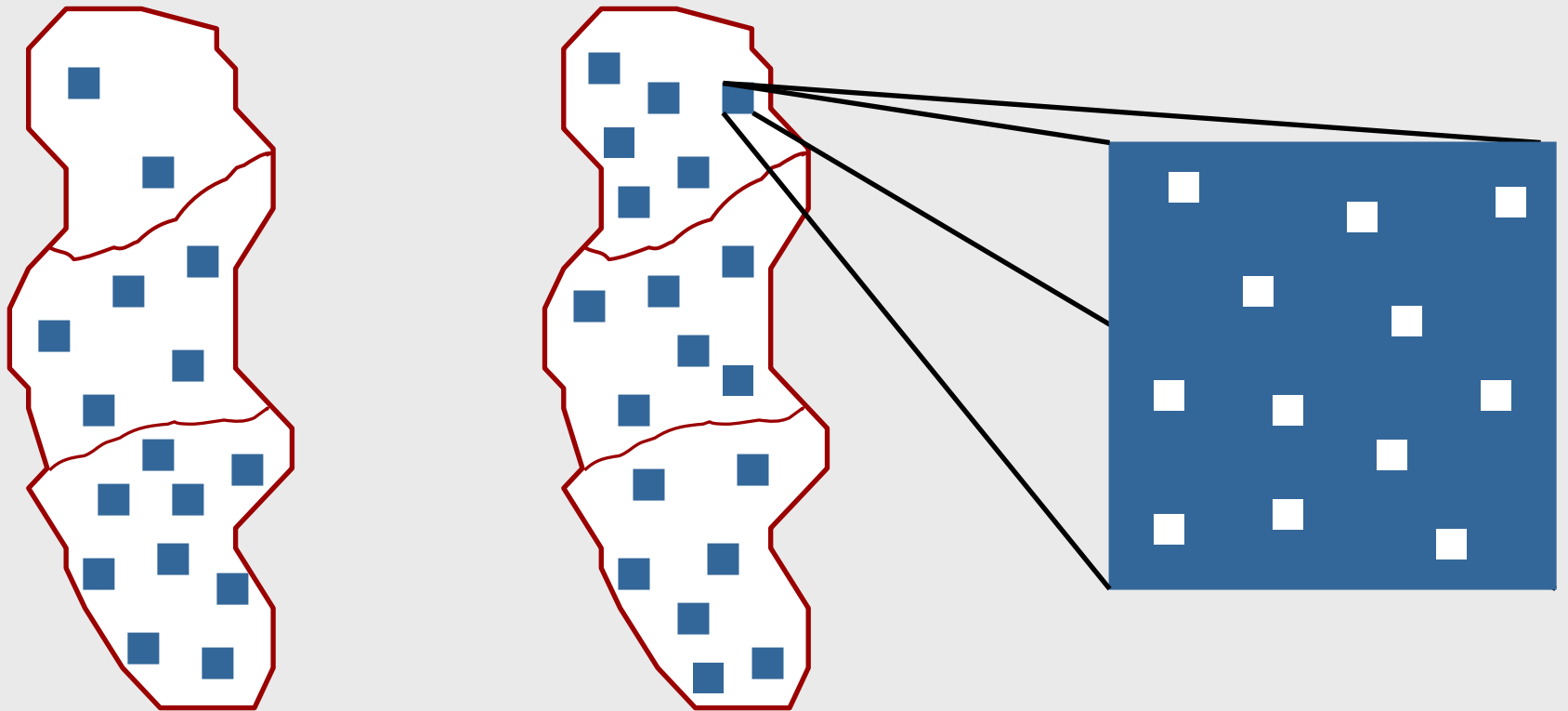
Different Statistical Designs can Provide Different Types of Information.

Status – What is the Condition of the Resource?

Trend – How is the Condition of the Resource Changing Through Time?

What Design Should be Utilized for Regional Sampling.

Panel	n	Time Periods (= years)						
		1	2	3	4	5	6	7
Design 1 Always Revisit n=60								
1	60	X	X	X	X	X	X	X
Design 2 Never Revisit n= ∞ or N								
1	60	X						
2	60		X					
3	60			X				
4	60				X			

Always Revisit or Never Revisit?

- The Always Revisit Design is the Most Efficient For Trend as Long as There is a High Correlation of an Attribute Value Through Time At A Site (minimizes Site Variation).

- The Never Revisit Design Samples More Sites So Provides a Better Estimate of Status (Larger Sample Size → Smaller S.E. for Site Mean).

Mix and Match Design

Panel	n	Time Periods (= years)						
		1	2	3	4	5	6	7

Design 3 Augmented Serially Alternating   n= 210

Panel	n	1	2	3	4	5	6	7
1	50	X				X		
2	50		X				X	
3	50			X				X
4	50				X			
Common	10	X	X	X	X	X	X	X

What is the Population of Interest.

- This is where there is the Greatest Inconsistency Among Large-Scale Sampling Groups – Example; Streams.
  - Groups Agree – Reaches and Wadeable Streams.
  - Groups Disagree
    - EMAP – All 1st through 3rd Order Streams.
    - AREMP – All 6th HUC, then All 1st through 3rd Order Streams Within Watershed.
    - PIBO – One Low Gradient, Higher Order Stream in all 6th HUC Watershed.

Having Different Populations of Interest Limits (Makes More Difficult) Integrating Data Sets.

- As Long As Surveys Are Probabilistic, We Can Combine Disparate Surveys By Using Strata.

- Common Strata can Be Utilized To Identify Common Populations for Inference.

- Best Strata Are Likely Process Related and Easily Mapped.

One Strategy For Devising Strata.
Example-Adding Sediment <2mm.

Response Variable	C	SP	PB	PR
Bankfull Width	🔵	🔵	🔵	🟦
Thalweg Profile	🔵	🟦	🔵	🔶
D50	🔵	🔵	🔶	🔶
Percent Fines	🟦	🟦	🔶	🔶
Habitat Units	🔵	🔵	🔵	🟦

🔶 Very Responsive

🟦 Secondary Response

🔵 Little Response

High Gradient ⟷ Low Gradient

Montgomery and MacDonald 2002

Need to Allocate Most Effort Where Greatest Variability or Effect.

- Every Group Should Sample at Least A few of Each Process Group.
- Majority of Samples should be in Low Gradient Response Reaches.
- Perhaps 20% in Moderate Gradient Streams.
- Perhaps 10% in Higher Gradient Stream.

Exact Allocation of Effort Should be Based Specific Objectives.

Steps Toward Consistent Regional Aquatic Survey; Conclusions

- Adopt Probabilistic Sampling.
    - Should be Based on the Balanced Sampling Design Utilized By EMAP.
- Be Designed to Evaluate Trend as Well as Status.
    - We Should Utilize the Augmented Serially Alternating Design if Use of Permanent (Repeat) Sites indicate High Correlation in Attribute Values Among Revisits.
- Ensure Sample Allocation to All Stream Reaches Relative to Variability and Response.

Response Design

So What Type of a Response Design is Needed in a Consistent Aquatic Monitoring Program?

- Should Focus on Attributes That can Detect Change and/or are Highly Correlated With Fish Populations.

- A Core Suite of Attributes Should Be Identified for Integrating Monitoring Efforts – These Should be Indicator and Process Attributes.

- Protocols for the Core Attributes Should Be Consistently Applied.

- Core should Include Biotic Components.

Response Design Should Be Based on Responsive Indicators – Bank Measure For Example.

ATTRIBUTE	CV	DIF	SS
Bank Stability	16	8%	88
Bank Angle	22	15%	48
Undercut %	48	28%	149
Undercut Depth	43	35%	45

Collect Data on Attributes so we can Compare Apples to Oranges.

Variable	Managed Mean (STD)	Unmanaged Mean (STD)
Elevation	1395.33 (406.5)	1659.75 (422.2)
Area	39.87 (28.57)	31.32 (25.69)
Stream width	5.67 (2.943)	6.69 (4.088)
% Federal	95.40 (7.74)	99.84 (0.665)
Precipitation	810.26 (302.6)	1013.63 (284.3)

Need Both Indicators and Process Attributes
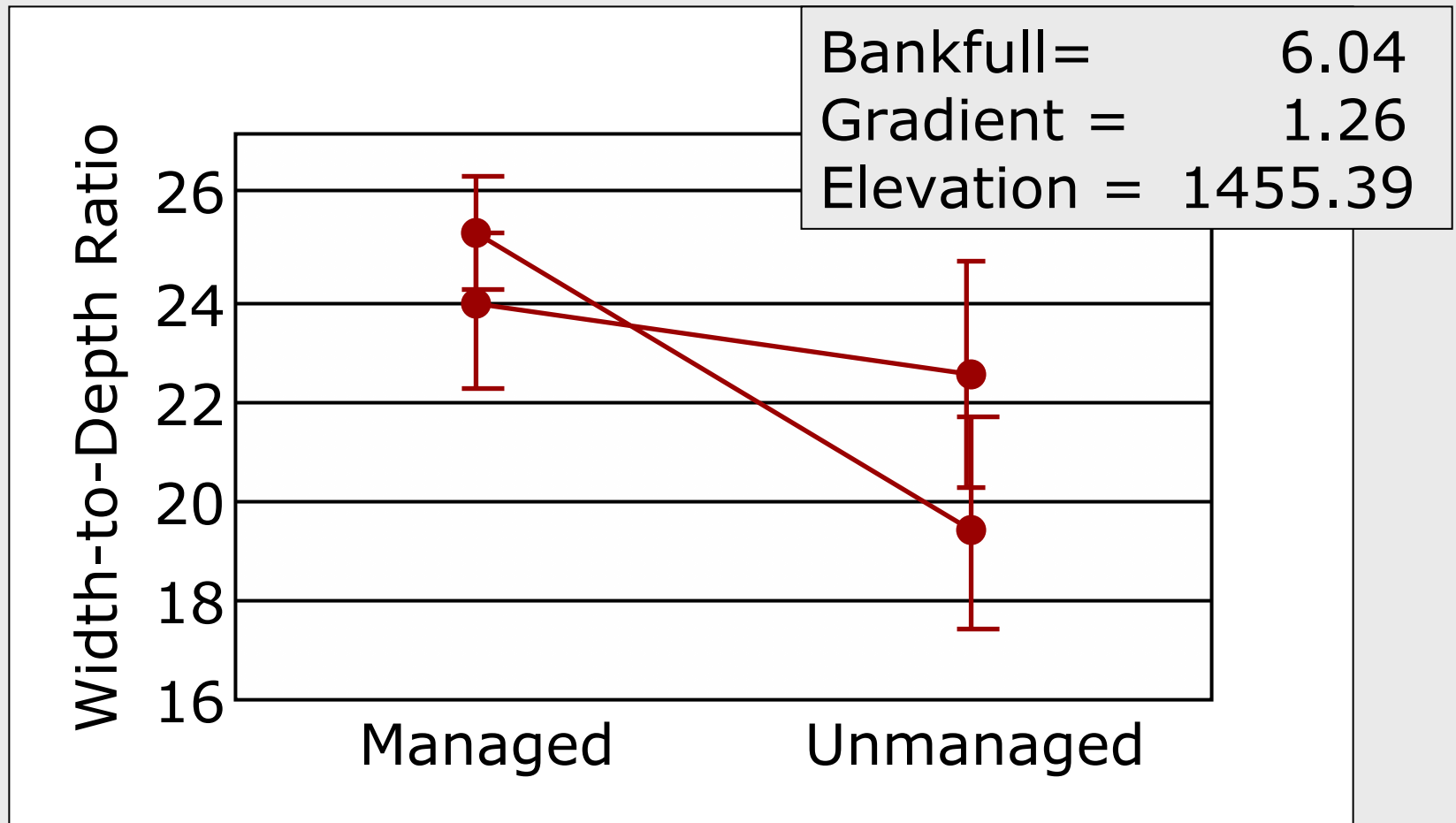
Consistent Protocols; Are they Required for Integration?

- Having Consistent Protocols are Not Necessary if;
  - Different Protocols Have the Same Year, Site, Site by Year, Treatment, Among Observer, Index Window, and Random Error Terms.
- Without Consistent Protocols we Have little Hope for Integrating Disparate Monitoring Program.

Conclusion For Response Design; Identify Short List of Consistently Evaluated Attributes.

- Gradient
- Sinuosity
- Bankfull Width
- Habitat Composition
- Residual Pool Depth
- A Substrate Measure
- A Bank Measure
- Wood Count

- Bug Index
- Fish Numbers

Final Choice of these Attributes Would be Based on Objective Criteria Using Data.

Procedural Design

Why Worry About A Procedural Design?

- Based on a Recent Paper, Monitoring Programs are Just as Likely to Fail as a Result of Procedural Problems as They are to Fail Due To Poor Statistical Design or Choice of Response Design.

- This Suggest Seeking Consistency In the Monitoring Plan Without Maintaining Day-to-Day Relevancy with the Agencies Affected by the Collected Data will Undermine any Plan.

Can We Learn From Past Monitoring Efforts?

Best Place to Look is at the Region 6 Stream Survey Efforts.

- Survived Due to Regional/Forest/ District Commitment.

- Generated a Decent Understanding of Baseline Condition (Status).

- Many of the Biggest Issues Were Process Oriented – Training, Application, Data Input, Analysis, and How to Make the Data Usable.

Procedural Requirements For Large-Scale Aquatic Monitoring Programs.

- National/Regional/Forest/District Commitment.
  - Continual Interaction between Monitoring Groups and all Levels of Field Personnel.
    - Without Continual Dialogue, Large-Scale Monitoring Programs will go Away.

Procedural Requirements for Large-Scale Aquatic Monitoring Programs.

- Generate Understanding.
  - Provide Timely Analysis. Data Needs to Be Summarized And Available During the Spring Following Data Collection.
  - Be Willing To Include New Analysis That Are Requested By Federal Sponsors, Federal Coordinators, Tribal, and State Partners.
  - Create Scientifically Defensible Analysis of Regional Aquatic Trend, Status, and Condition.

Procedural Requirements For Large-Scale Aquatic Monitoring Programs.

- Assure Consistent Application of Program.
  - Monitoring Teams Need to Deal With Training, Collection, Data Input, and Summarization.
  - Assure Quality Assurance Quality Control.
  - Use/Help Field Personal When and Where Possible.

Conclusions

- We Need to Move Toward Probabilistic Sampling.

- If a Consistent Monitoring Program is to Be Focused on Trend (Repeat Sites), We Need To Evaluate Sample Design and Understand The Role And Placement of Permanent Sites.

- We Need A Better Defined Sampling Universe and a Consistent Set of Strata to Hang All Our Samples On.

Conclusions

- We Need to Come to an Agreement on Core Attributes and Common Protocols.

- We Need to Constantly be Involved With, and Responsive to, the Field Units.

To Answer the Question I Posed at The Beginning of This Talk.

A Consistent Monitoring Program; Are We Ready Yet?

I Think We Are Ready,

But Are We Willing?